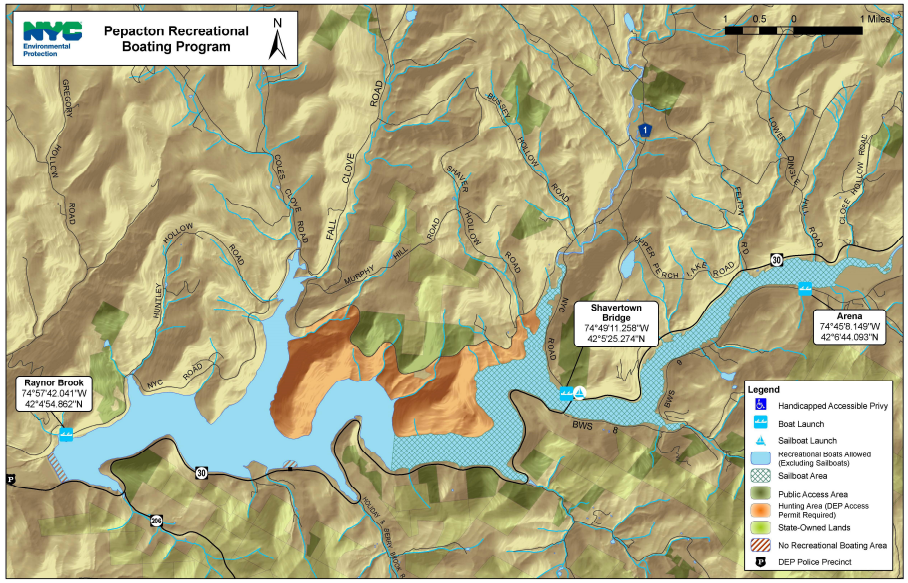
Managing Events and Extremes in Water Supplies (MEWS)

https://mews-water.com/

What is a Hydroclimatic Extreme Event?

- Large Rainfall / snow melt event that leads to high river discharge and nutrient and sediment loading to lakes and reservoirs
  - Increases water storage
  - Reduces water quality – increased loading
- Lack of rainfall or drought that
  - reduces water storage
  - Affects water quality – promotes internal processes



Objectives

- To develop a freely available comprehensive modelling tool that will allow stakeholders to evaluate the effects of extreme hydro-climatic events on drinking water quality.
- To co-develop the modelling system with stakeholders from each demonstration site, including scenarios, workflows, documentation and training
- To increase our understanding of the complex regulation of the effects of extreme events and antecedent conditions on water quality at the water supply withdrawal under present and future conditions.

CONSORTIUM DESCRIPTION

All groups in this project have extensive water quality modelling experience and have been at the forefront of lake and reservoir model development.

Uppsala University Sweden & Swedish University of Agricultural Sciences

- Consortium coordinator
- Issues related to dissolved organic carbon (DOC) and its effect on drinking water treatment

Helmholtz-Centre for Environmental Research Germany

- Issues related to dissolved organic carbon (DOC) and eutrophication

Israel Oceanographic Limnological Research

- Issues related to water scarcity and eutrophication

Bolding & Bruggeman Denmark

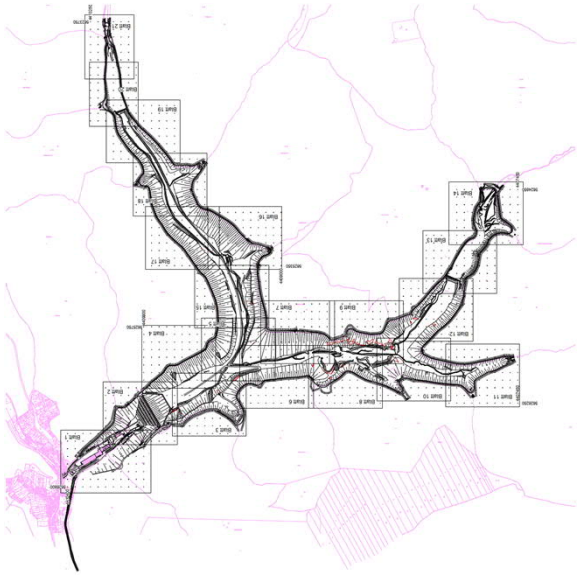
- SME specializing in numerical models for lakes and oceans.
- Will develop modelling tools and provide modelling support

Centre National de la Recherche Scientifique (CNRS) France

- Experts in modelling DOC biogeochemistry

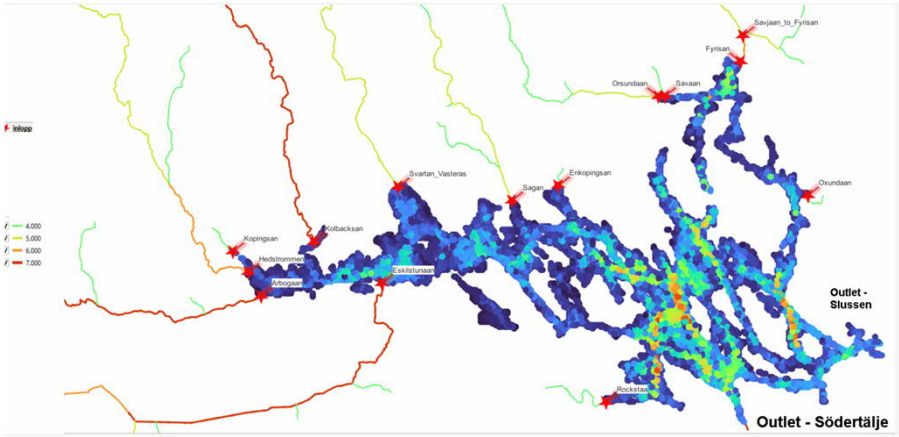
Demonstration Sites

Ohra Reservoir Germany



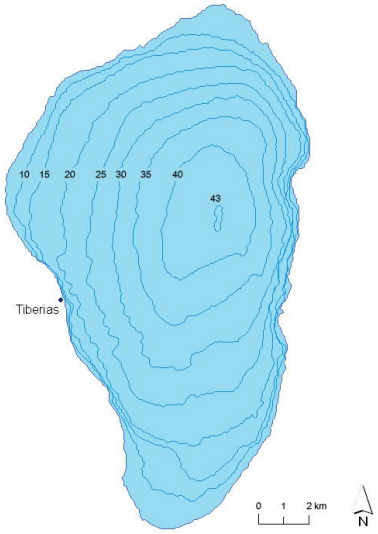
Surface Area 0.82 km^2
Residence Time ~ 1 yr
Population Served ~ 400 000

Lake Mälaren Sweden



Surface Area 1140 km^2
Residence Time 2.2 yr
Population Served ~ 2 000 000

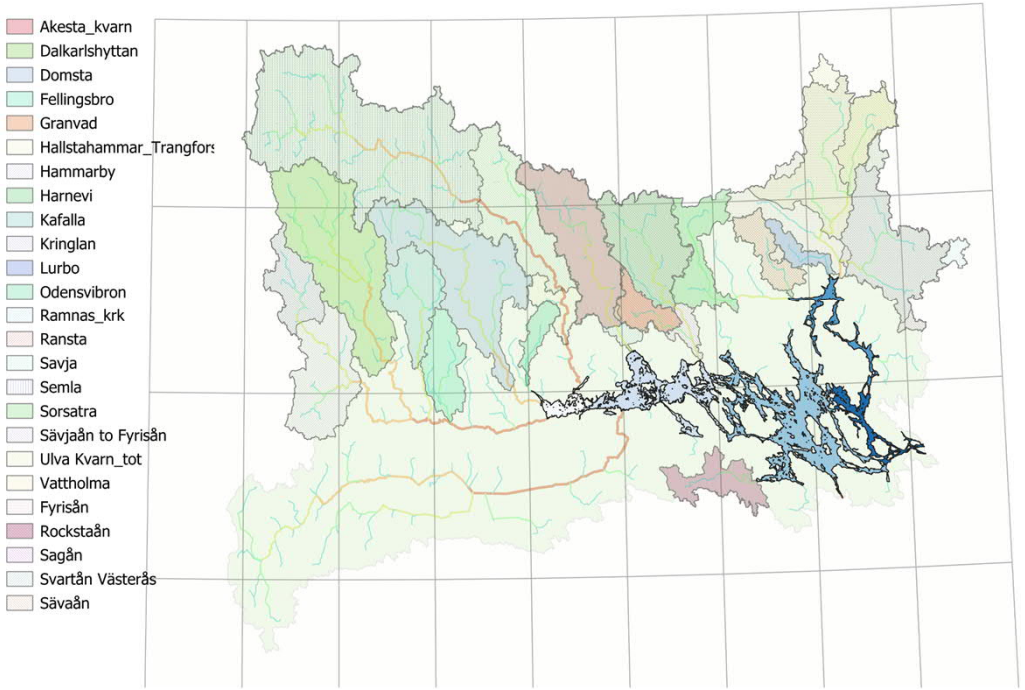
Lake Kinneret Israel



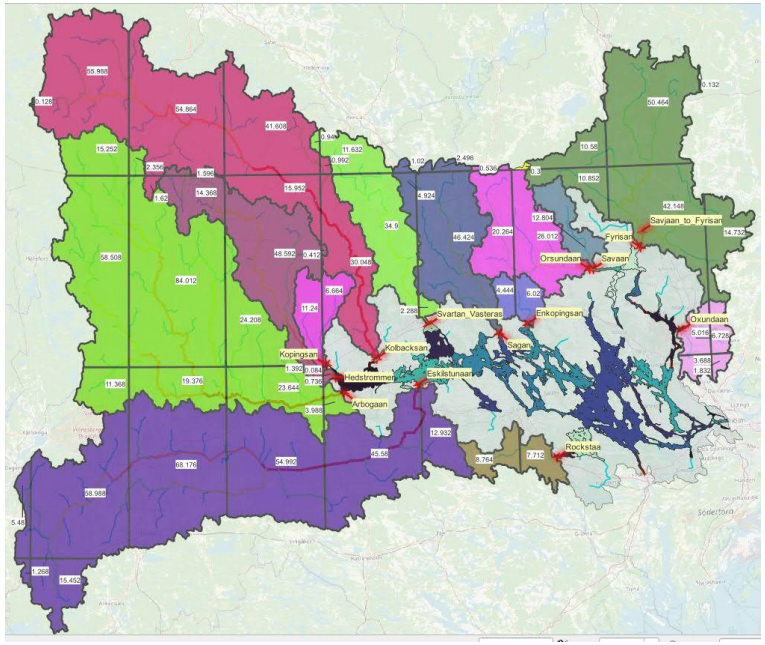
Surface Area 166 km^2
Residence Time 4.8 yr
Population Served ~ 1 900 00 + contributions to Jordan

Watersheds Used for Model Calibration and Simulation

21 Watersheds with Discharge Used for Model Calibration

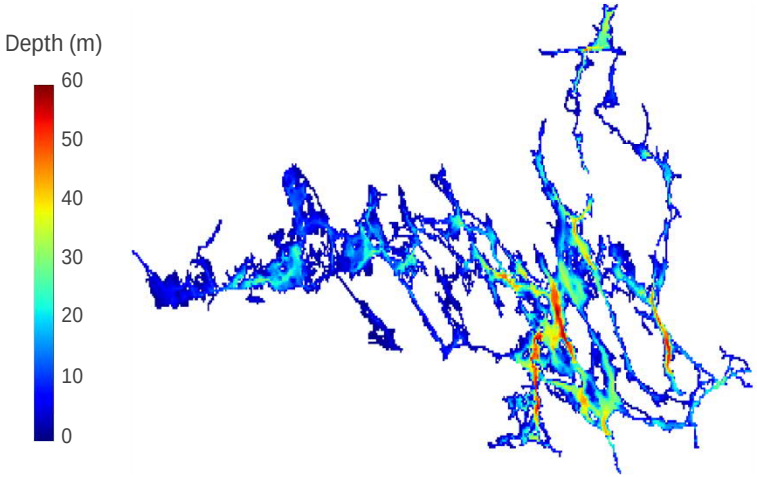


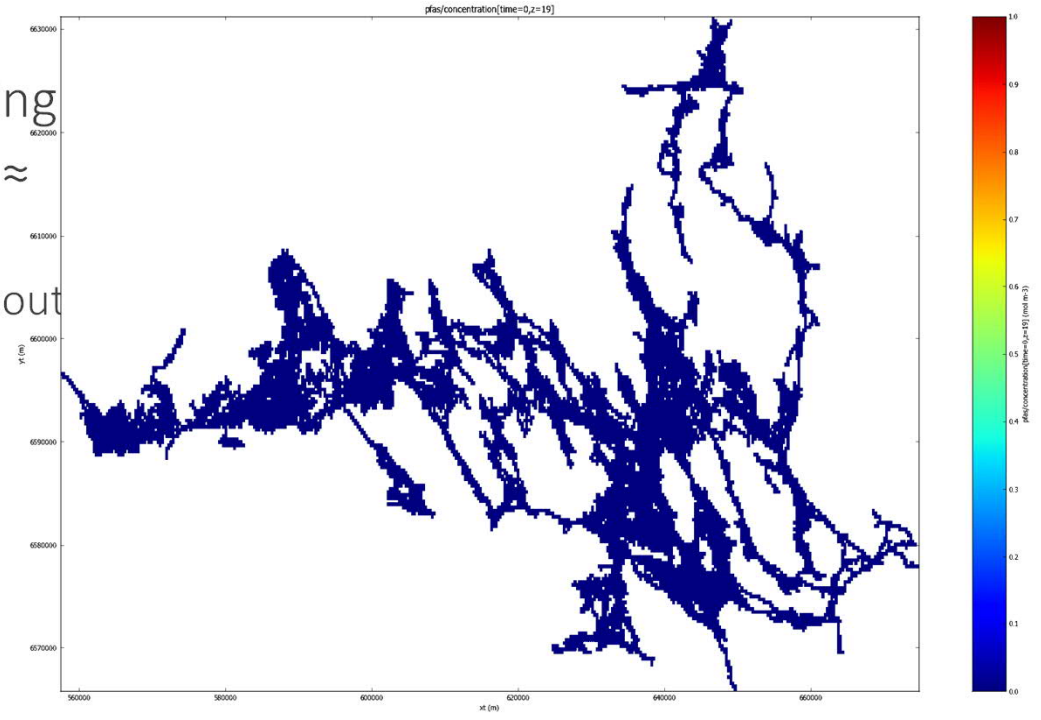
Major Watersheds That Will be Used to Simulate Lake Input Loading



Lake Modelling

- PyGETM
  - Spatially-varying weather forcing
  - Takes long time to run (1 year ≈ 16 hours runtime).
    1. Ekoln-only setup – 1 year in about 1.5 hours



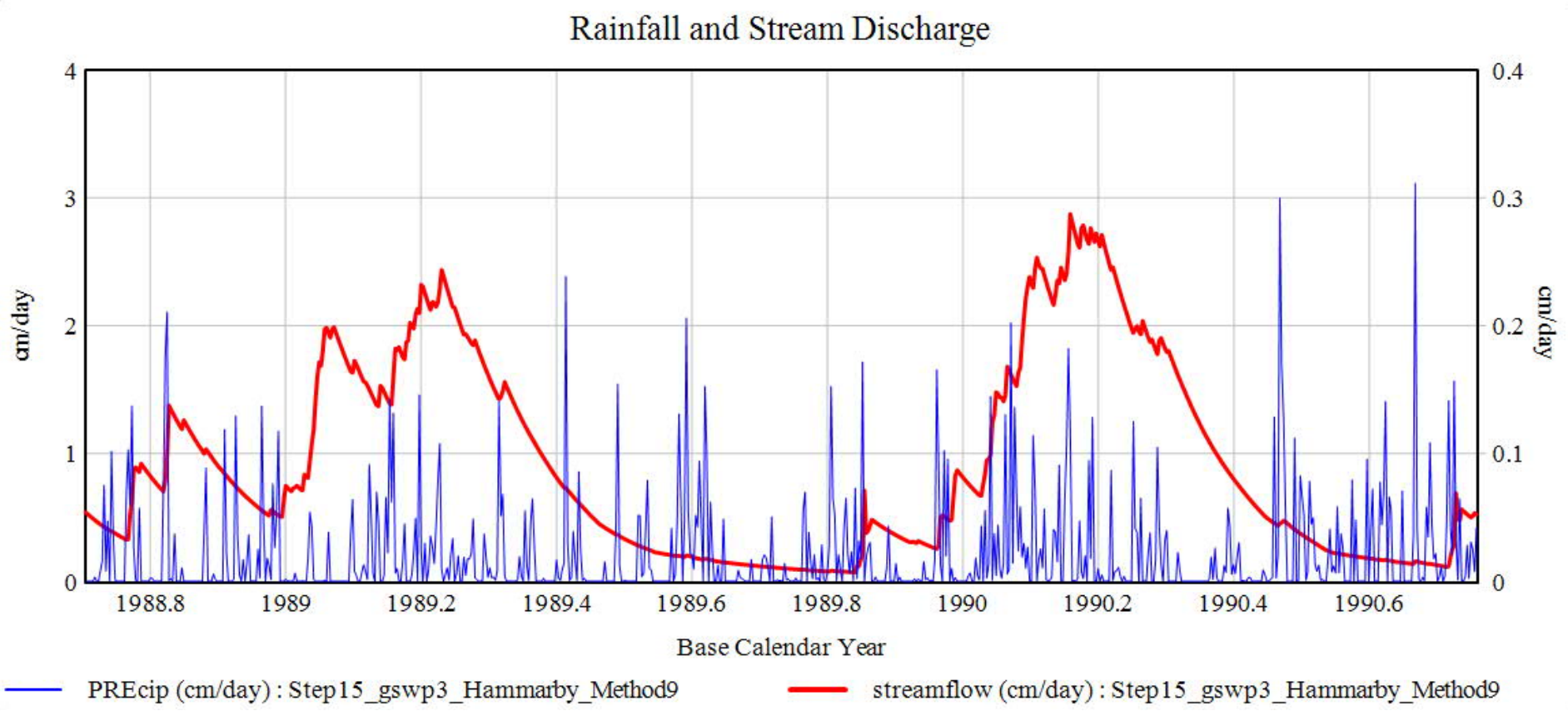


All Extreme Events are not Equal

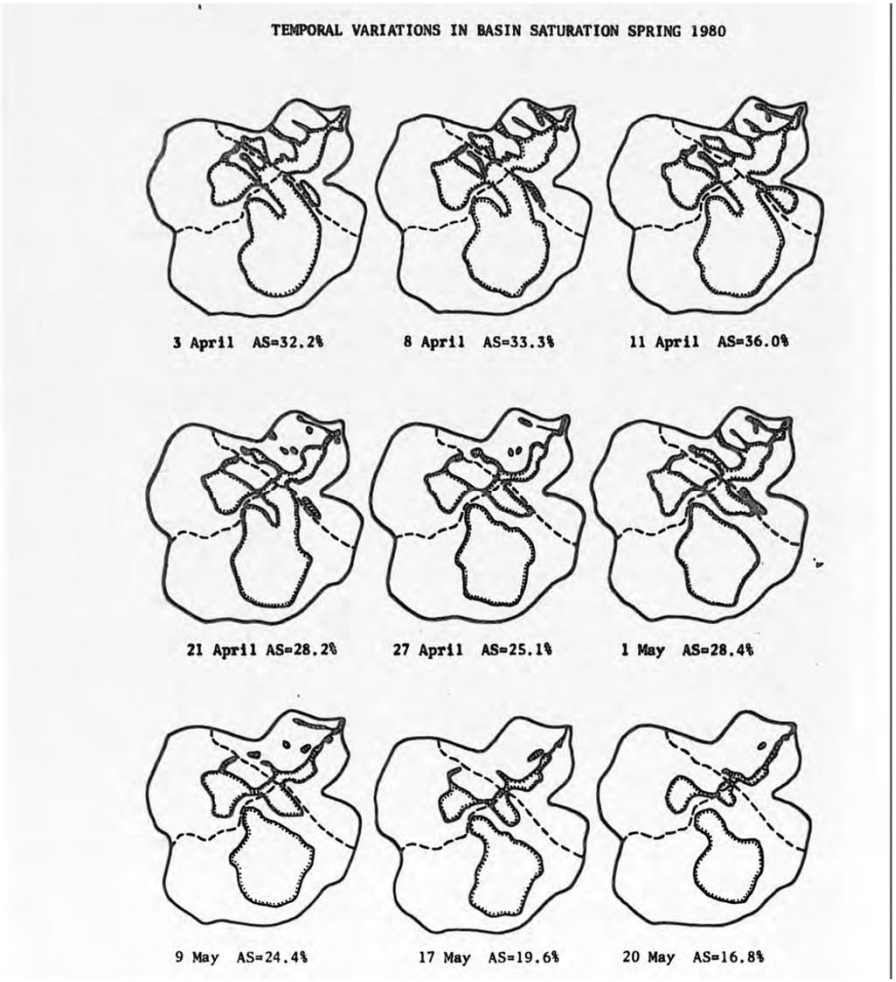
Ohra Reservoir – Study Site Germany

- Drinking water reservoirs are often created in impounded river basins. Major inputs are separated from water supply withdrawal
- It is not only event input but the transport and processing of the input that affects water quality at the withdrawal
- The effect of an extreme event is not just related to increased precipitation amount, but also antecedent watershed and waterbody conditions:
  - Soil moisture – Runoff Response
  - Thermal structure and water level – Reservoir transport and biogeochemistry
- Extreme events related to reduced precipitation and reduced water level increase the importance of internal reservoir processes
- Antecedent conditions affect not only watershed and water body response but also the coupling between systems.
- Antecedent conditions are complexly affected by climate change

Seasonal Antecedent Effects on Hydrology



Event Antecedent Effects on Hydrology



Hydrological Sciences–Bulletin–des Sciences Hydrologiques, XX, 3 9/1975

RECOGNITION AND PREDICTION OF RUNOFF-PRODUCING ZONES IN HUMID REGIONS

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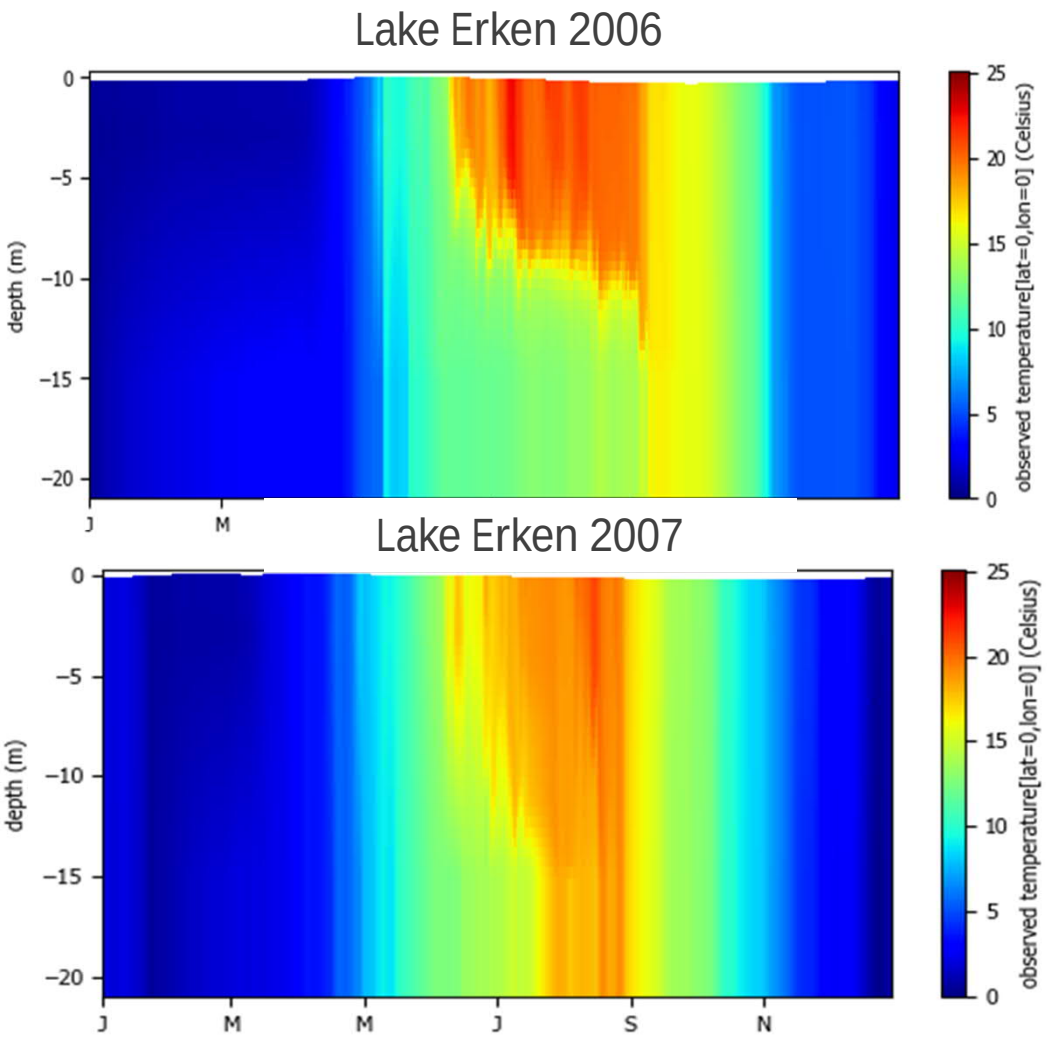
MS. received 2 June 1975

Abstract. Field experiments on representative and experimental basins have demonstrated the validity of the variable-source concept of storm runoff production in humid regions. Storm runoff is produced on small portions of a catchment which vary in extent during and between storms. In order to make the variable-source concept useful for flood prediction, water quality management, and land planning, it is necessary to develop routine methods for recognizing and quantifying the seasonal and in-storm variation of the saturated runoff-producing zones. The paper suggests various hydrological, pedological and vegetative indicators of this variation. They can be used for prediction of the maximum seasonal extent of saturated conditions, and also for day-to-day accounting, probability studies, and for analysing the probable effect of some environmental change. The techniques are illustrated with examples from representative and experimental basins in the United States and Canada.

Antecedent Conditions also Affect Limnology

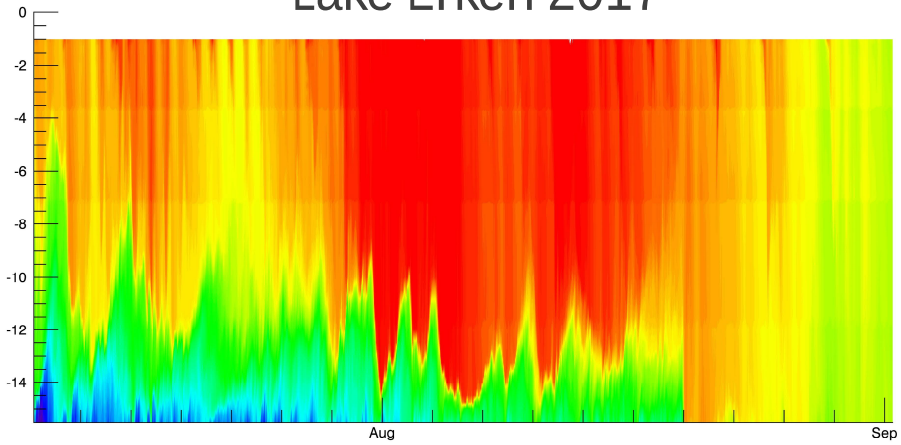


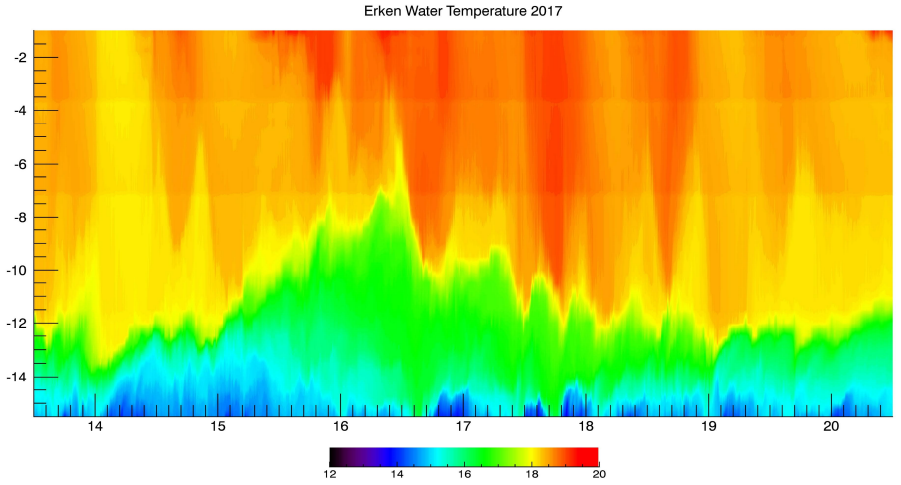
Timing of Stratification and depth of mixing will affect transport through the lake

Temperature of water will affect biogeochemical processes

Event Antecedent Effects on Limnology

Lake Erken 2017





LIMNOLOGY and OCEANOGRAPHY

ASLO

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Antecedent lake conditions shape resistance and resilience of a shallow lake ecosystem following extreme wind storms

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Timing of spring events changes under modelled future climate scenarios in a mesotrophic lake

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Revised: 17 January 2024 – Accepted: 11 March 2024 – Published: 18 April 2024

Question:

- How does weather history affect the coupling of watersheds and lakes by acting on antecedent conditions?
- Are extreme events in lakes the consequence of unusual combinations of watershed and lake antecedent conditions?
- How will this be effected by climate change?

Analysis:

Run MEWS coupled model simulations over long-term historical and future climate scenarios – evaluate conditions that lead to lake events

Delema:

ISIMIP

- Historical 1970-2014 (45y)
- Future 2015-2100 (85y) * 3 scenarios
- 5 GCM models
- 1500 years min 130 years

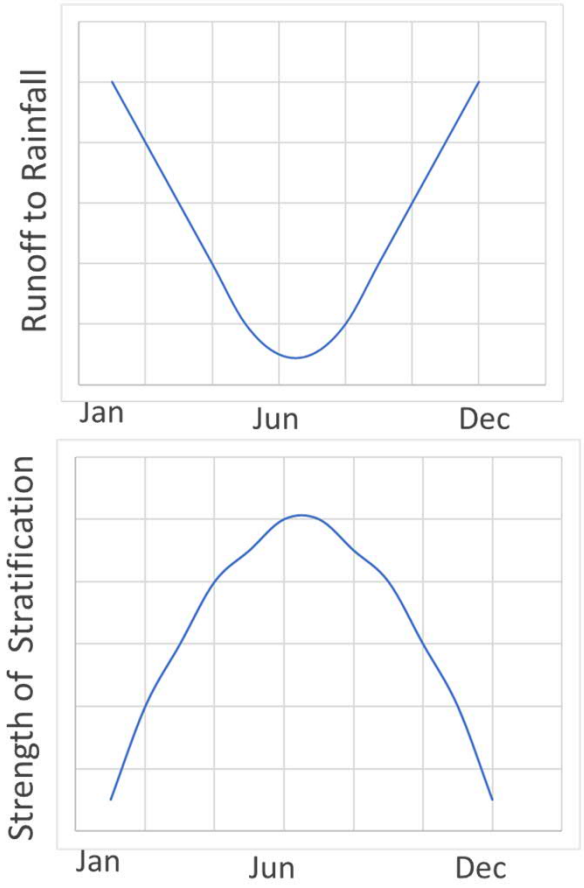
Run time GETM

1yr = 12 h

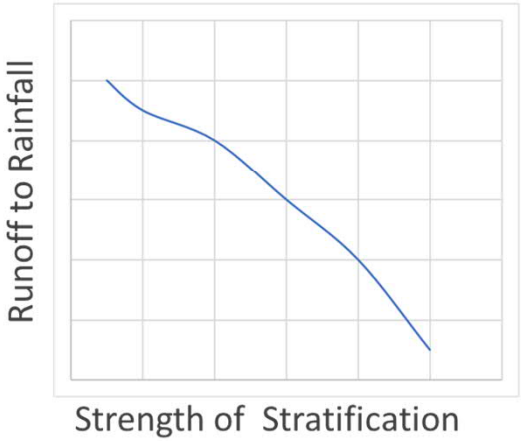
130 yr = 65 days

1500 yr = 750 days

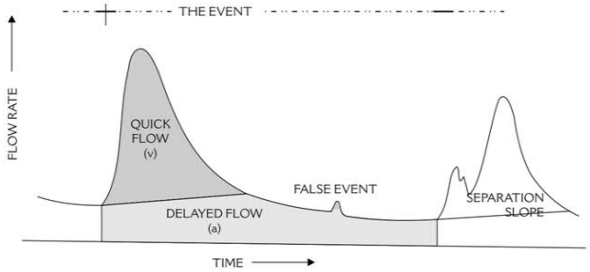
Can we develop a screening method to identify events that can later be examined in greater detail?



What Do We Expect From Antecedent Conditions?

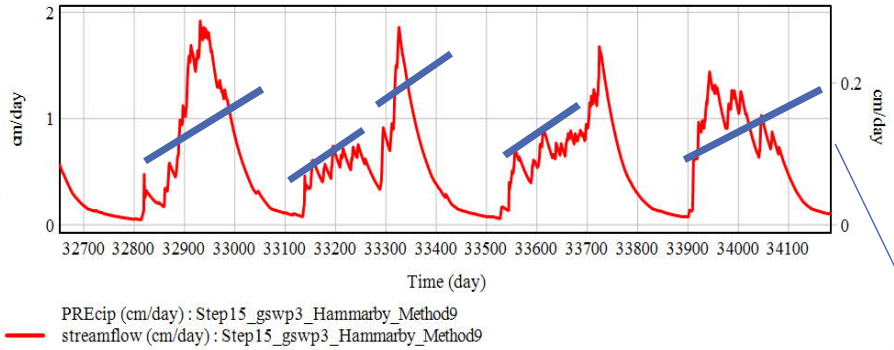


A screening method to identify interesting events in long climate records

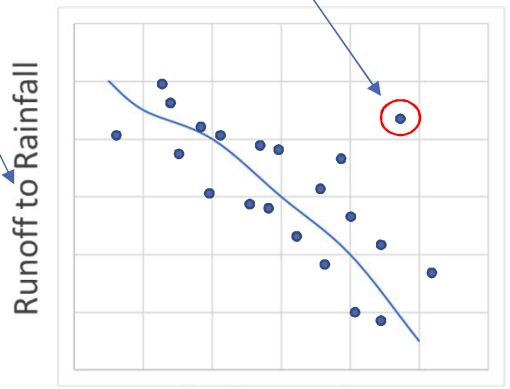


Hewlett, J.D. and Hibbert, A.R. 1967: Factors affecting the response of small watersheds to precipitation in humid areas. In Sopper, W.E. and Lull, H.W., editors, *Forest hydrology*, New York: Pergamon Press, 275–90.

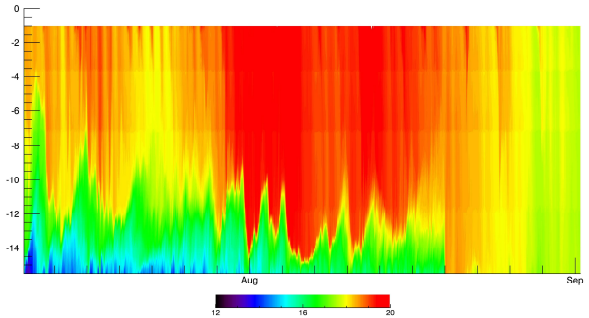
Runoff /rainfall simple hydrograph separation



Event of Interest?

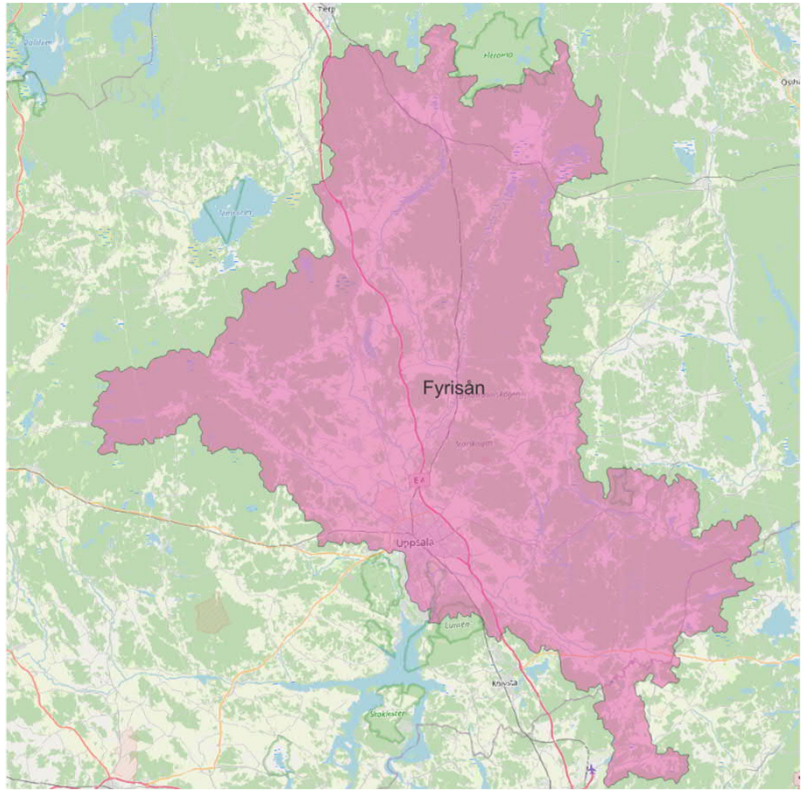


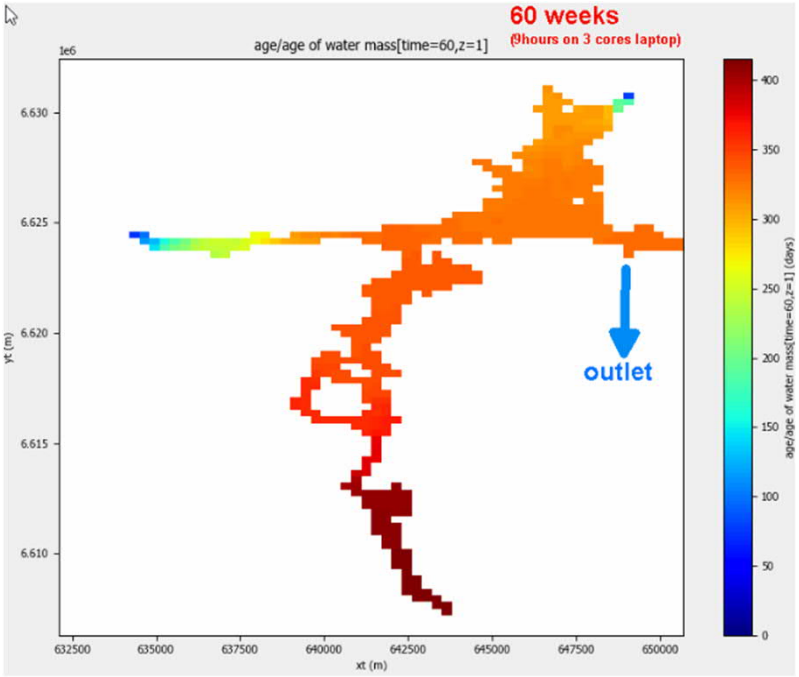
1D simulation GOTM
Index of Stratification



Lake Analyzer

First test Fyrisån and EkoIn





Questions